

SPaCE- Sensory Processing and Classroom Environments: Methodology for evaluating and improving teaching spaces for better student experience.

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Abstract: SPaCE combines building assessment and pedagogic research to establish improved 'inclusive learning spaces' to improve the health and wellbeing of all students, including those with a Sensory Processing Disorder (SPD). A person with SPD finds it difficult to process and act upon information received through the senses. This creates challenges in performing countless everyday tasks and impacts upon many aspects of life including motor clumsiness, behavioural problems, anxiety, depression and school/college/university performance. Preliminary research has shown that this can affect the quality of the student experience and thereby their progression and retention. Whilst it is accepted that students with physical disabilities have specific environmental requirements and, where possible, reasonable adjustments are made, specific requirements for students with SPD are not normally considered at University. Practitioner experience in other educational contexts suggests that the physical layout of a classroom may be adapted to maximise student participation and engagement, enabling all students to benefit from a non-traditional classroom layout, but no academic research exists. The SPaCE methodology involves capture of data about the physical environment (lighting, temperature, air quality etc) simultaneously with the student experience in typical classrooms (through physical measurements, Sensory Profile questionnaires, observations, interviews and focus groups). This multi-method data set will provide us with a better understanding of conditions and how they are experienced by students, and to identify areas for improvement, to be implemented in a campus demonstrator project. The aim of the project is to provide guidelines for improved teaching provision, in terms of sensory processing issues, for dissemination within the wider education sector. This paper reports on an on-going project – the main rationale and methodology are described, with a focus on the mixed-method data collection approach and setup of the pilot study.

Keywords: Sensory Processing Disorder, Higher Education, classroom environments

Introduction

There is no typical Higher Education student cohort any more. Student profiles are becoming more and more diverse, as on-campus support for a growing number of disabilities and additional support needs are identified and catered for. At the majority of UK HE institutions it is now an expectation that there will be an array of support strategies in place, ranging from one-to-one mentoring and tutor support to physical electronic devices with software and apps to support the students with their studies. However, the physical layouts of the classrooms, laboratories and lecture theatres remain as they were originally designed, usually several decades earlier. Traditional lecture theatres are still commonplace in most universities, with students seated side-by-side in rows, forwards-facing and semi-circular in nature. Seminar rooms and classrooms typically resemble a traditional school classroom, with side-by-side desks in neat rows, again forwards-facing. These layouts leave little flexibility for the lecturer or tutor to introduce interaction during a lesson. Furthermore, if a student has any sensory difficulty related to sound, sight, smell/taste, touch, movement or balance, the restricted layouts can pose additional barriers to learning. This project seeks to combine a mixed method data set to explore the sensory challenges that many of our students face, in combination with real-time physical measurements related to indoor environmental quality (IEQ), student perceptions and classroom observations. SPaCE is novel in its attempt to gather such a wide sensory data set,

for purposes of enhancing the student experience, and thus learning, within Higher Education.

Sensory Processing

Sensory integration is defined as 'The neurological process that organises sensation from one's own body and from the environment and makes it possible to use the body effectively with the environment' (Ayres, 1989; Parham & Mailloux, 2015). It refers to the way the central and peripheral nervous systems manage incoming sensory information from the sensory organs, namely visual, auditory, tactile, taste, smell, proprioception and vestibular, and turns them into appropriate motor and behavioural responses. Sensory functioning characteristics include registration (or detection) of stimuli, modulation (regulation of level or intensity), discrimination and praxis (planning of new motor acts). Sensory Processing Disorder (SPD) exists when sensory signals are either not detected or do not get organised into appropriate responses. It is a neurological dysfunction affecting the adequate reception, modulation, integration, discrimination or organization of sensory stimuli, and the behavioural responses to sensory input (Tomchek, 2001).

Students, typically young adults, at University with autism spectrum disorder (ASD) may present sensory processing alterations, which inevitably impacts upon their daily functioning and educational experience. Sensory dysfunctions are not always present in or exclusive to ASD, as they are also present in other disorders and disabilities (Cheung & Siu, 2009; Ermer & Dunn, 1998; Leekam et al., 2007; O'Brien et al., 2009; Rogers et al., 2003; Wiggins et al., 2009). Whilst it is anticipated that the SPaCe project may indirectly reveal findings that could be classed as comparative data for ASD and neurotypical students, it will take a general approach of SPD to include other disorders and disabilities such as Attention Deficit Hyperactivity Disorder, Cerebral Palsy, Dyslexia (Specific Learning Difficulties), Dyspraxia/Developmental Coordination Disorder and Fragile X Syndrome, to enable a full rich representation of our student cohort.

On the basis of sensory integration theory (Ayres, 1979), a model for classifying patterns of sensory processing dysfunction according to individuals' behavioural response to stimuli and neurological thresholds was proposed (Dunn, 1997). It describes four modalities:

- Sensory sensitivity (distress and distraction from sensations)
- Sensation avoiding (controlling or limiting the amount and type of sensations)
- Low registration (lack or low awareness of sensations)
- Sensation seeking (enjoyment and interest in increasing sensations).

Both 'sensory sensitivity' and 'sensation avoiding' represent hypersensitivity, whereas 'low registration' and 'sensation seeking' represent hyposensitivity. Several studies have compared sensory processing characteristics of children with ASD with those of children with typical development to compare experiences and observations in the classroom environment to the home environment. Hypersensitivity has been reported to be more common in people with ASD than hyposensitivity, with prevalent sensory modalities tending to be auditory and tactile (Fernandez-Andres et al., 2014; Fernandez et al., 2018; Ashburner et al., 2008; Kientz & Dunn, 1997; Rogers et al., 2003; Tomchek & Dunn, 2007; Wiggins et al., 2009). For example, hearing is reported to be one of the most affected in the classroom environment. Hearing is characterized by low sensory adaptability, so that an auditory stimulus (a sound), even if repeated or predictable, is not easy to get used to. In the case of the classroom environment, excessive and unpredictable noise is common in modern

classrooms. “Academic material is usually presented through verbal instruction, which is by nature rapid and transient and thought to be difficult for children with ASD to process” (Quill, 1997), especially in the presence of competing background noise (Alcantara et al., 2004).

In other school classroom studies, touch was the least affected sensory modality in the home environment, but the most affected modality in the classroom environment (Fernandez et al., 2018). Touch is characterized by high sensory adaptability. At University, students are often seated in groups, akin to a school classroom, and may similarly be exposed to unpredictable tactile input, which is potentially invasive for them (Dunn, Myles et al., 2002; Dunn, Saiter et al., 2002).

Sensory Processing and Higher Education Teaching Spaces

This paper defines an under-explored aspect related to increasing student engagement and subsequently performance: teaching and spatial arrangements (classroom environments) in response to SPDs. Whilst it is accepted that students with physical disabilities have specific environmental requirements and, where possible, reasonable adjustments are made, specific requirements for students with sensory processing disorders are not normally considered at University. The big cultural drive within Universities to embed the inclusive practice of Universal Design for Learning (UDL), an established educational framework that guides the development of flexible learning environments that can accommodate individual learning differences, provides an opportunity to address this issue.

The most common way to assess sensory processing characteristics in children has involved parent or teacher reports using standardized questionnaires, such as the Sensory Profile, SP (Dunn, 1999), and the Sensory Processing Measure, SPM (Parham et al., 2007). These allow a detailed assessment of the child’s sensory profile based on estimates by adult references of observed behaviour. Little research exists at present in relation to young adults at University. To date, we have not found any other studies conducted on young adults with SPD that compared their sensory processing characteristics in different Higher Education classroom settings, which are likely to have unique seating arrangements, for example, seated in rows in lecture theatres, and thus pose additional sensory challenges for some students.

Given that students, typically young adults, are capable of conducting self-completed questionnaires, sensory processing characteristics in Higher Education settings may be assessed through the Adolescent/Adult ‘Sensory Profile’ self-questionnaire (Brown & Dunn, 2002), which is designed as a trait measure of sensory processing patterns and effects on functional performance. In these questionnaires, each student will answer questions regarding how he or she generally responds to sensations, as opposed to how he or she responds at any given time. This should enable the capture of more stable and enduring sensory processing preferences of a student, providing greater understanding about why individuals engage in particular behaviours and why they prefer certain environments and experiences.

The quadrant scores derived from the 60-question Adolescent/Adult Sensory Profile represent patterns of sensory processing as described in Dunn’s Model of Sensory Processing (Dunn, 1997). Based on the intersection of two continual (neurological threshold and behavioural response/self-regulation), this model describes quadrants identified as Low Registration, Sensation Seeking, Sensory Sensitivity, and Sensation Avoiding. Each quadrant has its own score; it is possible for an individual to have any combination of scores. Some

patterns that appear to be mutually exclusive (e.g., sensation seeking and sensation avoiding) may be present in the same student. In addition, data will be provided on sensory category scores of Taste/Smell, Movement, Visual, Touch, Activity Level, and Auditory; these categories are distributed throughout the quadrants.

Practitioner experience in other educational contexts suggest that the physical layout of a classroom may be adapted to maximise student participation and engagement, enabling all students to benefit from a non-traditional classroom layout. Also, links have been made between general IEQ and building performance and attainment, e.g. Burman et al., (2018). However, no academic research exists regarding the effect of environmental factors and physical layout upon classroom dynamics, participation and performance in Higher Education settings.

Methodology

The SPaCE project seeks to establish a methodology that involves capture of data about the physical environment (lighting, temperature, air quality etc) simultaneously with the student experience in typical classrooms (through physical measurements, observations, questionnaires and focus groups). The long term aim of the project is to compare the different types of sensory modulation vulnerabilities (over-responsiveness, under-responsiveness and sensory-seeking behaviours) in different academic environments, between groups of students with SPD (or ASD) and neurotypical students and to develop guidelines for the design/layout of comfortable/supportive HE teaching and learning spaces for all students, including those with SPD. The project tasks have been grouped into four stages as shown in Figure 1.

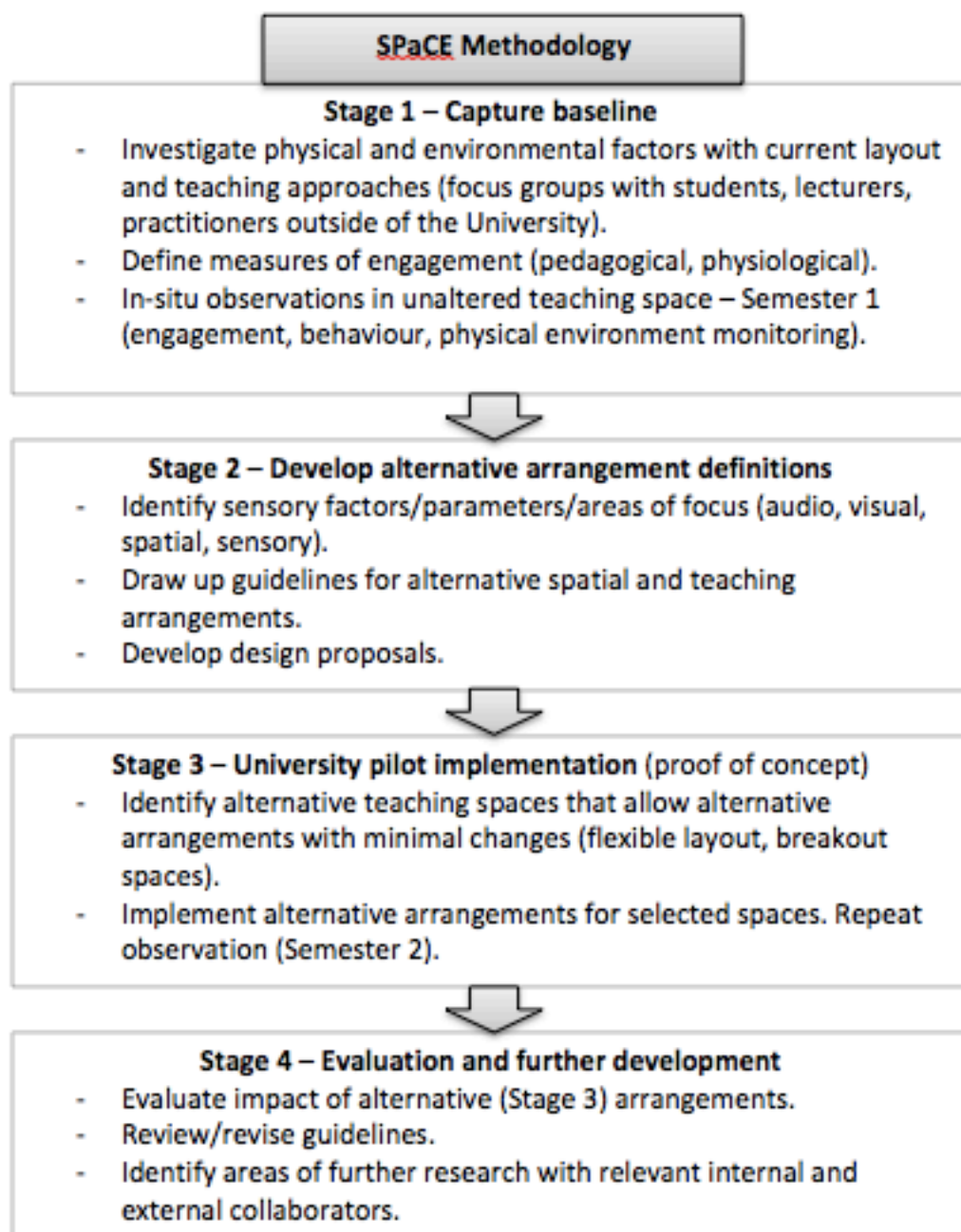


Figure 1. SPaCE methodology.

The project is currently at Stage 1, with a pilot study being developed. The following sections give an overview of the data collection strategy and setup of the pilot study.

Mixed Methods Approach

In order to evaluate performance/conditions within buildings in terms of Indoor Environmental Quality (IEQ), guidance and recommended values are available for a wide range of parameters. Guidance documents relevant to schools includes BB101 on ventilation, thermal comfort and air quality (DfE, 2016) and BB93 on acoustic design (DfE, 2014). It is, of course, notoriously difficult to define 'comfortable' conditions that work for

all building occupants. Metrics such as PPD (percentage of people dissatisfied) are used as indicators as to what conditions would be acceptable by most occupants.

However, as the focus of this study are students with SPD, the range of 'comfortable' or 'acceptable' conditions is likely to be more difficult to define, and additional parameters need to be considered, i.e. personal space, touch. Evaluating teaching environments in regards to SPD thus requires understanding of environmental conditions as well as human perception and comfort issues. Therefore, a methodology must include measurement of physical parameters that affect personal comfort and sensory processing as well as collection of qualitative data in regards to individuals' perception of the conditions, their wellbeing and comfort.

Such mixed methods approaches are increasingly common in post-occupancy evaluations for building performance evaluation and IEQ research. For example, the Education and Skills Funding Agency's methodology for Building Performance Evaluation includes questionnaires, interviews and focus groups, as well as collection of quantitative data (ESFA, 2017). A good example for the use of mixed methods approach in an educational settings is provided by Burman et al., 2018, who linked various data sources, such as logging (temperature and air quality), occupant surveys, energy use analysis and educational performance measures, in order to gain a holistic view of building performance in regards to energy use, occupant comfort and educational attainment in schools. Numerous studies have been conducted in regards to the effect of comfort and classroom design on learning in schools (e.g. Barrett et al., 2013; Tanner, 2008) however, few studies are available for university environments (Temple, 2008). Particularly relevant studies are described in Yang et al. (2013), who linked classroom attributes to student satisfaction and performance and in Castilla et al. (2017), who used qualitative data from student feedback to establish design factors for university teaching spaces. The latter study highlighted the need to link those to physical parameters as a crucial next stage. These studies of university spaces provide valuable insights into the connection between the physical classroom layout, student perception and learning effectiveness for the general student cohort (Bassford & Snape, 2017). The current study is aimed at extending this to students with SPD.

For the SPaCE project, a mixed methods approach has been designed that utilizes a combination of common building performance assessment tools, such as environmental monitoring, observations and occupant feedback collection, but is adapted to investigate further factors, specifically related to sensory processing, using the Sensor Profile self-questionnaire as well as interviews and focus groups. An overview of main parameters and associated data collection tools is given in Table 1.

[illegible]

Pilot Study - Physical Measurements Overview

Room/Teaching Space

A flexible teaching space on campus has been identified as a location for the pilot study (Figure 2). The room has a number of desks and chairs and an open floor space, approximately 12m length x 7.5m width. It can be set up in different layouts, such as an informal student study/revision space, a small group/individual personal tutorial setting with small meeting tables, or as a series of rows or adaptable groups of tables to facilitate a seminar or problem-solving class.



Figure 2. Flexible teaching space identified for pilot study.

In order to capture the special environment that the students experience (rather than just the floor layout), 3D scanning will be used. This will provide a clearer understanding of the space that is available for each occupant and is intended to be linked to spatial perception data and comfort feedback collected through the survey/questionnaire.

Physical data logging

Visual environment monitoring: Field-of-view luminance images will be captured at regular intervals, using High Dynamic Range (HDR) imaging. This is a proven method for assessment of the luminous environment, in which fish-eye cameras are used to capture luminance images of the field of view of building occupants (Painter et al., 2016). The purpose of this data is to quantify the visual environment; this can provide information on the uniformity of light distribution, identification of problem areas etc, which can then be linked with the student perception feedback, i.e. to identify what conditions may be problematic or indeed desirable.

Thermal environment: Non-intrusive HOBO data loggers (Onset, 2018) will be positioned at different locations within the teaching space to capture temperature data as well as humidity data throughout the study period.

Auditory: Sound level measurements will be conducted throughout the study at different locations, co-located with the HOBO data loggers.

Air quality: Carbon dioxide concentrations in the space will be monitored with standard HOBO data. In addition, personal exposure data will be collected with diffusive sampling, using axial samplers that can be worn by the participants, which can then be analysed for different components, e.g. linked to odours, occurrence of volatile organic compounds (VOC). This approach will allow a more detailed analysis of potential contaminants than standard CO₂/VOC measurements.

Next steps – Qualitative Data Collection

As noted at the outset, the project is in its early stages - once the measurement setup has been tested, it will be deployed in a number of live teaching sessions in order to capture the necessary qualitative data:

Observations of student behaviour

Prior permission will be obtained to discretely observe the behaviour, movement and interactions between our students during classroom activities. This will include an observation of the level of activity (hyperactive, appropriate, lethargic), attention, relationship with tutor/lecturer (if relevant), effort/motivation, relationship with peers and temperament of the student.

Deployment of Sensory Profile questionnaire

The Adolescent/Adult 'Sensory Profile' self-questionnaire (Brown & Dunn 2002) will be used to evaluate the students' sensory profile. Where necessary, this will be modified in order to ensure that perception data is captured in regards to the measured/monitoring data. The questionnaire will additionally include socio-demographic questions to ask students about their gender, age, educational level and background.

Data analysis of the student Sensory Profile data will be performed with the SPSS statistical package to compare the characteristics of sensory processing in the SPD Group with a Comparison Group. The results will then be analysed in conjunction with the IEQ data

within the identified teaching spaces and the classroom physical data that has been captured. The aim is to identify and correlate any prevalent sensory modalities highlighted within the student cohort with the physical IEQ data gathered, individual student perceptions of the environment and the discrete classroom observations of the students' behaviour.

The findings from this analysis will then inform next stages of in the SPaCE methodology, including testing of alternative classroom layouts and development of guidelines for HE (Figure 1).

Conclusions

The SPaCE project aims to evaluate sensory processing issues in Higher Education teaching settings. An ambitious mixed methods approach is being developed to collect sensory profile data from a varied student cohort and link it with physical measurement data and observations. The volume of data that will be captured, whilst potentially large and varied, is expected to provide insights into specific areas within classrooms or layouts of rooms that present or increase sensory challenges for our students. The aim is to use this information sensibly to improve the classrooms environments to provide the most comfortable learning experience possible for all students. Future work could include an on-going evaluation of student retention, progression and performance in relation to an implementation of our initial findings and recommendations.

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